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VEGETATIVE INDICATORS, SOILS, OVERSTORY CANOPY, AND NATURAL REGENERATION AFTER PARTIAL CUTTING ON THE DEAD INDIAN PLATEAU OF SOUTHWESTERN OREGON

by

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ABSTRACT

Natural regeneration in partially cut stands on the Dead Indian Plateau east of Ashland, Oregon, varies with soil nitrogen, overstory canopy, and associated vegetation. Overstory canopy and associated vegetation were used to calculate a predictive equation to identify problem areas before logging. Management recommendations are listed.

KEYWORDS: Regeneration (natural), logging (-regeneration, indicator plants, Oregon (Dead Indian Plateau).

INTRODUCTION

The Dead Indian Plateau occupies an area of approximately 90,000 acres (22,400 ha) at 4,000- to 6,000-foot (1,220- to 1,830-m) elevations east of Ashland, Oregon. It is characterized by dry summers with frequent growing-season frosts, gentle topography, and generally poor forest regeneration. The severe climate and large gopher populations eliminate most conifer seedlings in many Dead Indian clearcuts. Area land managers have partially cut many stands in attempts to ameliorate the harsh plateau environment--often applying successive light cuts to the same area. Natural regeneration varies in these partially cut areas. A few stands are well stocked, but regeneration is unacceptably sparse in most stands.

We studied partially cut stands and post-harvest regeneration for several years to identify the environmental factors associated with regeneration success. Several plot sizes and sampling designs were tested, and many environmental variables were measured during 1973, 1974, and 1975. After analyzing these early results, we used an efficient sampling design to relate vegetative indicators, soils, and overstory canopy density to levels of post-harvest natural regeneration in 1976. This 1976 study is summarized here.

METHODS

In 1976, 55 stands that were partially cut before 1968 were each sampled with 80 small 1/300-acre (0.0013-ha) plots at 1/3-chain (6.7-m) intervals. These 80 plots were located in clusters of 5 along a horseshoe-shaped compass line. To be stocked, a 1/300-acre plot had to contain at least one established post-harvest seedling more than 2 years old. Regeneration stocking percent was obtained by dividing 100 times the number of stocked plots in each area by 80.

Overstory canopy density (in percent) was measured at the center of each five-plot cluster with a spherical densiometer.[1] Species and estimated diameters of the two nearest trees also were recorded at the center of each plot cluster. The 16 canopy density measurements were averaged for each sale area, and the 32 species and diameter determinations were used to calculate overstory stand composition. Slope and aspect were measured at four points on each sale area and then averaged. A radiation index was obtained by using these average slope and aspect figures with the tables of Frank and Lee.[2] Area elevation was recorded.

A single pit as deep as the C horizon or 50 inches was dug to

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[1] 25 points on the densiometer mirror were dot-counted 4 times at each center, facing 4 directions, and the sum was recorded as percent canopy density.

[2] Frank, Ernest C., and Richard Lee. 1966. Potential solar beam irradiation on slopes: tables for 30° to 50° latitude. USDA For. Serv. Res. Pap. RM-18. 116 p. Fort Collins, Colorado.

sample soils on each area. Total depth to the C horizon was then measured in the field. Soil samples were collected at 10-inch (25-cm) depth from each sale area and brought to the laboratory for analyses of silt and clay content, total nitrogen, phosphorus, potassium, calcium, magnesium, sodium, sulfate sulfur, and cation exchange capacity.

The presence of all higher plant species encountered was recorded on each sale area. After average regeneration stocking percents had been determined for all 55 areas, the areas were ranked by stocking percent--highest stocking first, lowest last. By modifying the comparative frequency technique described by Warner and Harper,[3] we then considered the top 18 areas and bottom 18 areas as two stocking groups and compared them species by species. Species differing between stocking groups by seven or more areas were chosen as indicator plants and assigned numerical values corresponding to their group differences. The procedure is illustrated in table 1. Of 93 species

Table 1--*Example of indicator species selection and value determination*[1]

Species	Number of areas present		Top minus bottom	Indicator value
	Top group (18)	Bottom group (18)		
Pinus lambertiana	13	2	+11	26
Abies magnifica var. *shastensis*	7	1	+6	--
Agastache urticifolia	1	7	-6	--
Eriophyllum lanatum	2	9	-7	8
Delphinium spp.	1	15	-14	1

[1]Species were compared by listing number of areas present in the group of 18 best-stocked sale areas against number of areas present in the group of 18 worst-stocked sale areas. Species with differences of 6 or less (*Abies* and *Agastache* here) were rejected. Species with differences of 7 or more (*Pinus*, *Eriophyllum*, and *Delphinium* here) were selected and assigned indicator values determined by relative differences in presence. Negative differences were converted to positive values by adding 15 to all differences, both negative and positive. Nomenclature follows Hitchcock, et al. (Vascular plants of the Pacific Northwest. 5 vol., illus. Seattle, Univ. Wash. Press. 1955-69) and Peck (A manual of the higher plants of Oregon. 2d Ed., 936 p., illus., Portland, Oreg. Binfords and Mort. 1961).

[3] Warner, James H., and K. T. Harper. 1972. Understory characteristics related to site-quality for aspen in Utah. Brigham Young Univ. Sci. Bull. Biol. Series XVI (2):20 p.

compared in this way, 27 differed by 7 or more between stocking groups and were selected as indicators (table 2). The 27 indicator species were used to calculate a vegetation index for each sale area by averaging the indicator values of all species present on that area.

Table 2--*Indicator species and values to be used in predicting regeneration success under partially-cut overstory stands. A vegetation index may be obtained by averaging the values of all species present on a given area*

Species	Indicator value
Castanopsis spp.	26
Pinus lambertiana Dougl.	26
Pyrola picta (J. E. Sm.)	26
Arctostaphylos nevadensis Gray	25
Ceanothus velutinus Dougl.	25
Goodyera oblongifolia Raf.	25
Linnaea borealis L.	25
Apocynum androsaemifolium L.	24
Pyrola secunda L.	24
Chimaphila umbellata (L.) Nutt.	22
Anemone oregana Gray	8
Eriophyllum lanatum (Pursh) Forbes	8
Mitella spp.	8
Osmorhiza chilensis (Hook.) Arn.	8
Synthyris reniformis (Dougl.) Benth.	8
Achillea lanulosa Nutt.	7
Phacelia heterophylla Pursh.	7
Hydrophyllum fendleri (Gray) Hel.	6
Lathyrus nevadensis Wats.	6
Polemonium carneum Gray	6
Stellaria jamesiana Torr.	6
Vicia americana Muhl.	6
Collomia grandiflora Dougl.	5
Potentilla spp.	5
Ribes binominatum Hel.	5
Collinsia parviflora Dougl.	3
Delphinium spp.	1

Data were analyzed by stepwise multiple regression analyses. Regeneration stocking percent was the dependent variable in these analyses. Independent variables were:

elevation
aspect
slope
overstory canopy percent
vegetation index
years since sale
average overstory d.b.h.
percent white fir (*Abies concolor* Lindl. and Gord.) in overstory
percent Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) in overstory

percent incense-cedar (*Libocedrus decurrens* Torr.) in overstory
percent ponderosa pine (*Pinus ponderosa* Dougl.) in overstory
percent Shasta red fir (*Abies magnifica* Murr. var. *shastensis* Lemm.) in overstory
radiation index
soil depth
silt and clay
phosphorus
potassium
calcium
magnesium
calcium/magnesium ratio
sodium
total soil nitrogen
sulfate sulfur
soil cation exchange capacity

Easily measurable variables that were significantly correlated with regeneration stocking in these analyses were used in a final multiple regression equation.

RESULTS

Even a casual observer soon notices that forest regeneration is poor in many partially cut stands on the Dead Indian Plateau. More thorough investigation, however, shows that this situation is not uniform. Some of these stands lack any noticeable post-harvest regeneration. Other stands are well stocked with young, vigorous seedlings. Most stands fall somewhere between these extremes--regeneration is present but not abundant. Post-harvest natural regeneration stocking in the 55 partially cut sample areas ranged from 3 to 76 percent as measured on the eighty 1/300 acre plots established in each area (appendix). Environmental variables significantly correlated with stocking included soil nitrogen, overstory canopy density, and vegetation.

Total soil nitrogen was negatively correlated with regeneration stocking ($r = -.465$)--high levels of soil nitrogen were associated with poor regeneration, low nitrogen levels with good regeneration. Correlation coefficients (r values) do not imply cause-and-effect relationships, and low stocking associated with high nitrogen may be the indirect result of other environmental factors rather than a nitrogen-caused phenomenon. Higher soil nitrogen levels, however, often induce vigorous, succulent seedling growth--growth that is damaged more by frost than the less succulent growth that occurs when nitrogen is less plentiful. Seedling frost damage has been observed throughout the growing season on the Dead Indian Plateau, and the negative nitrogen correlation with stocking percent may be the result of frost sensitivity induced by soil fertility.

No obvious relationship between light and regeneration is evident on the Dead Indian Plateau. With the exception of the contrast between clearcuts and partial cuts, field observations revealed only

small differences in regeneration stocking associated with overstory canopy variations on any single area; and an optimum canopy density was difficult to identify. When average stocking levels for all 55 sample areas were plotted against average canopy densities on a coordinate system, a general trend toward higher stocking levels around 60-percent canopy density became apparent (fig. 1). When expressed as canopy density deviations from 60 percent, this trend was significant in a linear correlation analysis (fig. 2). All other things being equal, a canopy density of 60 percent seems to be optimum for natural regeneration on the Dead Indian Plateau.

The vegetation index derived from species presence data was significantly correlated with regeneration ($r^2 = 0.56$). Occurrence of the 27 species used in this index was closely associated with the occurrence of tree seedlings as expressed in stocking percentages. No cause-effect relationship is implied, but factors affecting regeneration levels also affect the occurrence of plant species. The plant species thus serve as integrating indicators of the environmental complex that determines regeneration success or failure. When vegetation index and canopy density (expressed as the deviation from an optimal 60 percent) were combined in a multiple regression

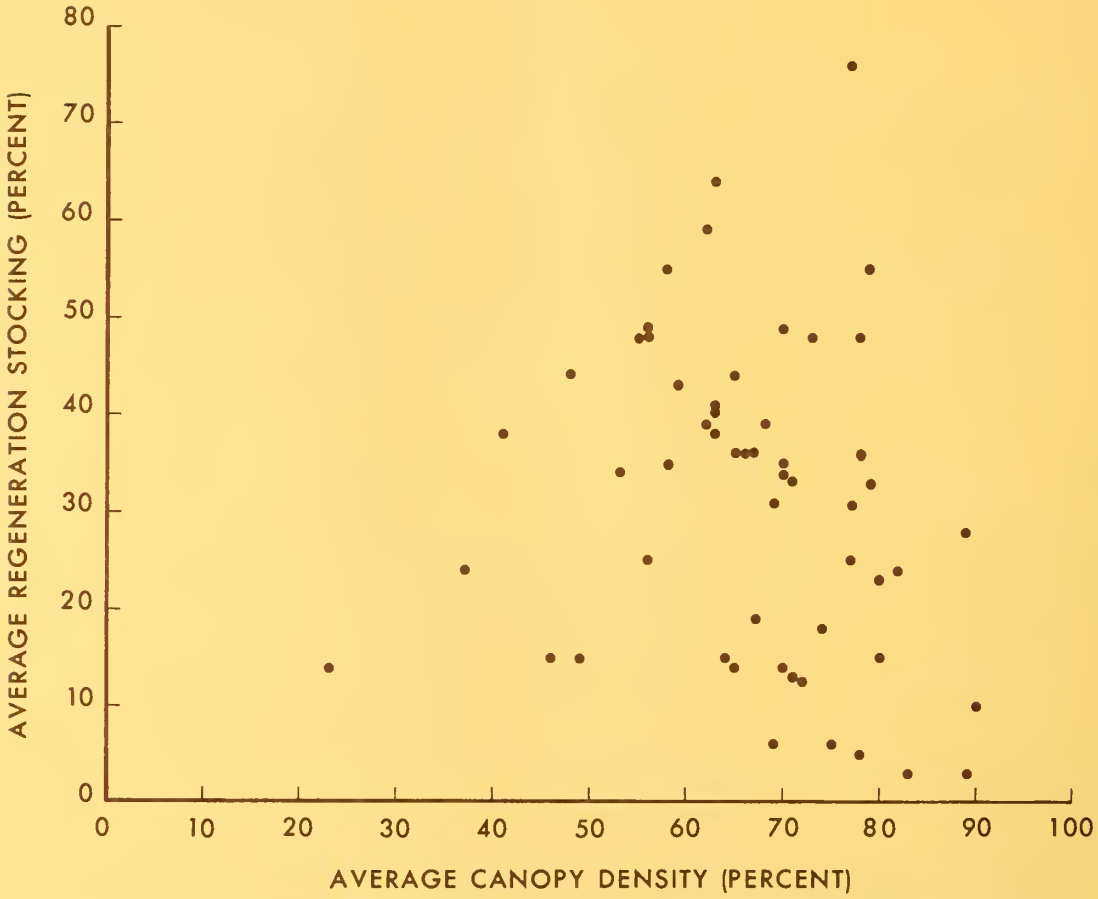

Figure 1.--Relation of average regeneration stocking to average canopy density on 55 partially cut areas.

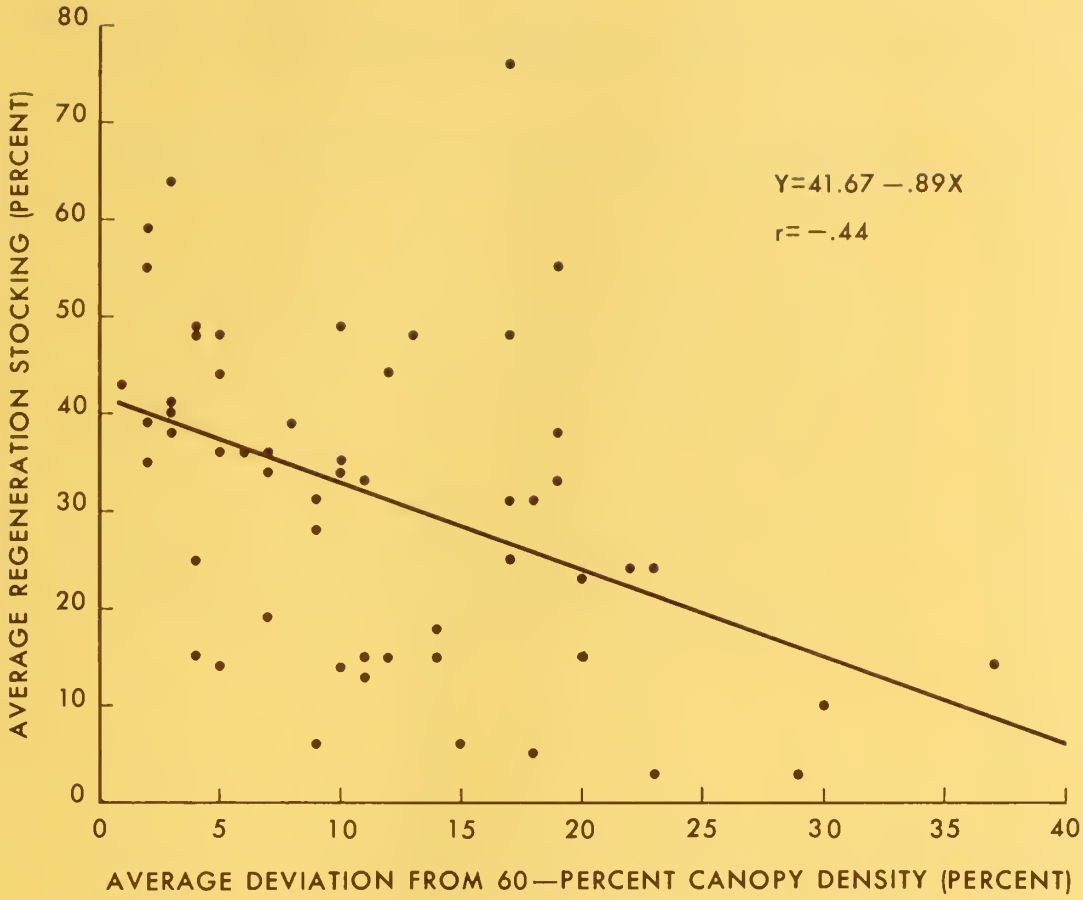

Figure 2.--Relation of average regeneration stocking to deviation from average canopy density of 60 percent.

equation, they accounted for 61 percent of the stocking variation observed among the 55 sale areas sampled in 1976:

$$\text{Stocking percent} = -5.161 + 4.753\ (\text{Vegetation Index}) - 0.09757\ (\text{Vegetation Index})^2 - 0.4938\ (\text{Deviation from 60 percent canopy})$$

$$r^2 = 0.61$$

Standard error of estimate = 10.6

Our field observations indicate that natural regeneration is adequate wherever the vegetation index is 20.0 or above.

MANAGEMENT RECOMMENDATIONS

As overstory canopy density and vegetative indicators are significantly correlated with natural regeneration success on the Dead Indian Plateau, they may be used in recommending management practices. Conditions most favorable for natural regeneration probably are also

most favorable for planted seedlings, so the following recommendations should apply to all partial cutting in the area...even when underplanting is practiced in a two-cut shelterwood system.

1. Determine a vegetation index for the area to be managed by using the plant species listed in table 2, averaging the values of species present. A minimum area of 4 acres (1.62 ha) should be examined.

2. If the vegetation index is 20.0 or above, remove enough sawtimber to create an overstory canopy density of 60 percent (60-percent crown cover, 40-percent open sky).[4] Rely on natural regeneration. Our sample of 55 partially-cut areas indicates that less than 20 percent of all stands on the Dead Indian Plateau will have vegetation indices of 20.0 or above.

3. In approximately 80 percent of all stands on the Dead Indian Plateau, vegetation indices will be less than 20.0. In these low-index stands, remove enough overstory to leave a canopy density of 60 percent, then underplant immediately. Do not depend upon natural regeneration--it will not be adequate where vegetation indices are below 20.0.

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[4] In making this recommendation, it is assumed that the overstory can be removed without undue damage to established regeneration.

APPENDIX

Partial List of Variables Measured, by Sale Area

Area location	Stocking (percent)	Elevation (feet)	Overstory canopy (percent)	Vegetation index	Years since sale	Total soil N (percent)	Soil C.E.C.[1] (meq/100g)
T. 39 S. R. 3 E., sec. 21	14	5,000	23	7.5	8	.18	28.49
T. 39 S. R. 3 E., sec. 21	15	5,050	49	8.2	35	.10	26.85
T. 38 S. R. 2 E., sec. 11	13	4,950	71	7.1	9	.22	35.55
T. 38 S. R. 2 E., sec. 13	6	5,350	69	5.8	10	.20	51.44
T. 38 S. R. 3 E., sec. 30	14	5,200	65	6.9	13	.14	45.20
T. 39 S. R. 3 E., sec. 17 and 18	6	4,960	75	10.2	14	.09	47.47
T. 38 S. R. 3 E., sec. 13	33	4,650	79	11.4	20	.15	32.54
T. 38 S. R. 4 E., sec. 19	25	4,650	56	5.9	10	.13	32.17
T. 38 S. R. 4 E., sec. 7	24	4,680	37	11.1	14	.20	38.40
T. 38 S. R. 4 E., sec. 26	48	5,600	55	14.9	12	.13	35.93
T. 38 S. R. 3 E., sec. 11	15	4,500	64	11.1	7	.10	36.62
T. 38 S. R. 3 E., sec. 21	25	4,700	77	8.6	18	.14	41.35
T. 38 S. R. 3 E., sec. 13	23	4,640	80	8.5	21	.17	34.80
T. 38 S. R. 3 E., sec. 13	36	4,680	66	7.9	9	.11	34.42
T. 38 S. R. 4 E., sec. 27	39	5,100	68	21.7	12	.06	23.82
T. 39 S. R. 3 E., sec. 27	34	5,000	53	13.4	6	.12	32.76
T. 38 S. R. 3 E., sec. 25	39	4,700	62	14.1	6	.13	30.48
T. 38 S. R. 3 E., sec. 35	35	4,800	58	12.6	13	.07	38.15
T. 39 S. R. 4 E., sec. 19	36	4,800	78	19.2	11	.10	30.50
T. 39 S. R. 3 E., sec. 25	38	5,000	63	15.5	23	.06	65.14
T. 39 S. R. 3 E., sec. 23	31	5,560	69	10.4	14	.12	31.25
T. 39 S. R. 3 E., sec. 14	24	5,440	82	9.0	14	.16	39.68
T. 39 S. R. 3 E., sec. 11	33	5,500	71	11.4	7	.12	48.87
T. 39 S. R. 4 E., sec. 9	55	4,600	79	15.9	9	.07	39.36
T. 39 S. R. 4 E., sec. 17	35	5,300	70	16.1	10	.11	54.29
T. 39 S. R. 5 E., sec. 3	43	5,550	59	15.3	11	.11	25.60
T. 38 S. R. 5 E., sec. 33	64	4,800	63	24.9	6	.05	30.50
T. 39 S. R. 3 E., sec. 26	36	5,700	65	14.1	12	.18	36.41
T. 39 S. R. 6 E., sec. 5	76	5,050	77	23.3	34	.11	28.57
T. 38 S. R. 6 E., sec. 29	49	5,300	56	24.6	24	.07	24.06
T. 38 S. R. 6 E., sec. 29	44	5,200	48	24.8	10	.06	26.53
T. 38 S. R. 5 E., sec. 34	38	6,040	41	13.8	4	.14	33.56
T. 38 S. R. 5 E., sec. 25	48	5,350	56	16.4	9	.14	24.81
T. 38 S. R. 5 E., sec. 30	59	5,100	62	22.8	13	.11	32.86
T. 39 S. R. 6 E., sec. 5	40	5,150	63	24.8	13	.06	25.61
T. 38 S. R. 3 E., sec. 15	41	4,600	63	11.1	10	.09	38.23
T. 38 S. R. 3 E., sec. 9	44	4,550	65	10.8	13	.04	41.53
T. 39 S. R. 3 E., sec. 5	5	5,800	78	5.9	10	.21	51.02
T. 39 S. R. 3 E., sec. 9	15	5,450	46	7.3	12	.12	40.49
T. 38 S. R. 3 E., sec. 33	19	5,400	67	6.9	13	.06	29.91
T. 38 S. R. 3 E., sec. 11	31	4,400	77	8.8	10	.14	41.78
T. 39 S. R. 3 E., sec. 7	36	5,250	67	6.1	11	.07	37.75
T. 39 S. R. 4 E., sec. 5	49	4,650	70	14.8	26	.14	31.15
T. 38 S. R. 4 E., sec. 35	55	4,750	58	20.7	12	.06	22.35
T. 39 S. R. 4 E., sec. 15	48	4,400	73	20.8	26	.14	27.89
T. 39 S. R. 3 E., sec. 30	14	4,800	70	5.9	12	.19	41.51
T. 39 S. R. 4 E., sec. 23	3	3,950	83	10.5	9	.08	22.81
T. 38 S. R. 3 E., sec. 32	15	5,750	72	7.8	15	.11	27.34
T. 38 S. R. 5 E., sec. 28 and 33	18	5,000	74	24.8	6	.24	30.68
T. 39 S. R. 6 E., sec. 7	48	5,800	77	19.0	11	.07	39.47
T. 39 S. R. 3 E., sec. 32	3	4,800	89	8.4	15	.09	47.79
T. 39 S. R. 3 E., sec. 34	28	5,050	89	8.4	15	.13	33.46
T. 39 S. R. 3 E., sec. 3	10	5,080	90	9.4	14	.23	37.70
T. 39 S. R. 3 E., sec. 23	34	5,600	70	12.6	7	.13	42.21
T. 39 S. R. 3 E., sec. 6	15	5,600	80	6.0	11	.17	51.02

[1] C.E.C. = cation exchange capacity.

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